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Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. I. NEW YORK, AUGUST, 1896. No. 6

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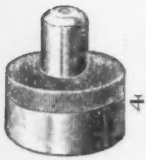

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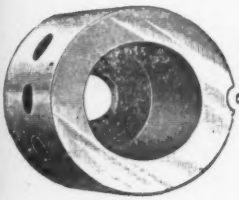

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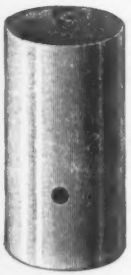

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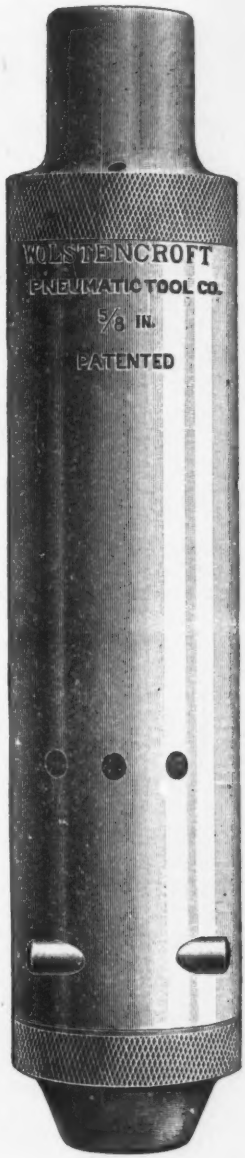

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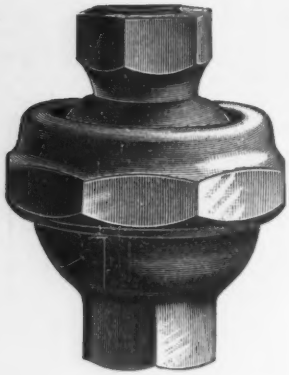

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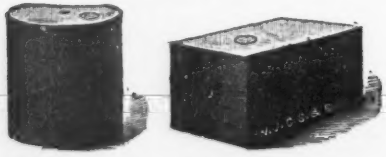

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Compressed Air

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Publisher
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Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. I. AUGUST, 1896. NO. 6.

AN accurate meter for measuring compressed air volumes is a much-needed apparatus. We can measure water, gas and steam by volumetric displacement, but the element of temperature should be considered in a reliable air meter. Under a constant pressure the volume of free air delivered through a pipe varies largely with the change in temperature.

The paper read by Mr. Arthur De Wint Foote, C. E., at the meeting of the American Society of Civil Engineers, recently convened in San Francisco, elicited much interest and no small amount of discussion.

The paper referred to makes a very elaborate and exhaustive report upon the operation of the compressed air transmission plant of the North Star Mine in Grass Valley, Cal., a brief description of which, compiled from this report, we here present.

The power station consists of a Pelton Wheel, 18 ft. 6 in. in diameter, attached direct to the shaft of a Rix Duplex Air Compressor, compound tandem type. The initial cylinders are 18 inches, and the second cylinders 10 inches diameter, with a 24-inch stroke.

The wheel is built up of angle iron plates riveted together to break joints, and is held concentric with the shaft, with 12 pair of radial spokes of 1¼-inch rod iron secured by nuts to the cast iron hub. The driving force being applied to the rim, is transferred to the hub by four pairs of 2-inch iron rods so arranged as to form a truss.

The wheel weighs 10,500 pounds, and runs at 110 revolutions under 750 feet head, developing upwards of 300 H. P. It is made of this large diameter for the purpose of giving proper speed to the compressor under the high head in this case available. The water is applied to the wheel through a variable nozzle controlled by a hydraulic regulator which maintains a uniform speed on the wheel with a variation from full load down to 25 per cent. of same, making its operation absolutely automatic, as well as economizing the water supply, no more being used at any time than required for the work.

The construction of the wheel, as will be seen, forms an ingenious mechanical combination, altogether novel and without precedent, affording an ample factor of safety with a very high peripheral velocity. The water supply is brought to the wheel through 2½ miles of 22-inch riveted pipe, affording sufficient capacity to develop 800 H. P. A 6-inch lap-weld pipe conveys the air at a pressure of 90 pounds from the power house to the company's shaft, 800 feet distant and 125 feet elevation. This is at present running a 100 H. P. pneumatic hoisting engine and a 75 H. P. compound pump, beside other pumps, drills, forges, etc.

The report above referred to shows that

repeated tests on this wheel, made by the most approved methods and checked up very closely, give the remarkable efficiency of 93 per cent. at full load; also an average efficiency of something over 90 per cent. for ¼, ½, ¾ and full loads. The suggestion has been made that the extraordinary efficiency here shown is accounted for in part by the unusual dimensions of the wheel. This, however, was shown to be incorrect, as equally high efficiencies have been obtained on Pelton wheels of much less than one-third this diameter.

The efficiency of compression and transmission from water wheel to motors, not including cost of reheating, is given as 79 per cent., making a most favorable showing for the plant as a whole, under the conditions installed. The application here described is also of interest as showing the remarkable flexibility of the Pelton system and facility of adaptation to all varying conditions.

WE frequently hear claims made for compressed air machinery that are open to the same criticism as the popular or empirical assertions based of course on belief, regarding the economy and performances of electricity. It is common knowledge that meteorology shows that there is tremendous power in the very elastic, flexible fluid called air. It was at one time the only motive power in navigation and more important in manufacture than water power. But the references to the enormous resources of air power are often made in such a way as to imply wonderful cheapness, and are quite sure to give the layman a very incorrect impression. The utility of the power of wind has nothing to do with air compression. Wind engines must be employed to make use of that waste energy. Perhaps the unsteady power of the wind engine can be made use of to better advantage in compressing air than in generating electric current. That, however, has not yet been found, so far as we are aware, but if it is proved, this will not alter the fact that the advance is due to wind engineering. You must first apply the power to the piston before you get your compressed air and the untold billions of horse power going to waste in the moving currents will not avail to effect this compression until "harnessed." "First catch your hare" is an old saying that has application in this connection.—*The Tradesman.*

A very excellent painting machine is manufactured in Europe that will paint flat surfaces and make artistic letters and figures. The paint is sprayed evenly and continuously on the work through a flexible tube and nozzle, supplied with compressed air, either from existing air mains in shops or from special compressors driven by belt from existing shafting, or by a steam engine or other motive power.

With any ordinary paint from 20 to 30 square feet of surface can be covered in one minute. For painting boilers, girders, bridges, wagons, railroad cars and work of similar character it is unsurpassed.

IT is supposed that, in consideration of the labor required to work an air pump, particularly one of the old days, they agreed to call the experiments "pneumatic," and to class the whole series of facts under one common title of Pneumatics. Compressed air is a simpler title, and one that conveys to the unmechanical mind an impression of the science of air power.

BOERHAAVE considered air as "a universal chaos of all kinds of created bodies, besides the matter of light or fire which continually flows into it from the heavenly bodies, and probably the magnetic effluvia of the earth. Whatever fire can volatilize is found in the air."

THE HARDIE AIR-MOTOR CAR.

NOW RUNNING IN NEW YORK.

(See illustration on cover).

The first of the two Hardie air-motor street cars to be tried by the Third Avenue Railroad Company, arrived in this city July 22d. It was shipped on a platform freight car on the New York Central Railroad from the works of the American Air Power Company at Rome, N. Y., where it was manufactured. The new car was taken from the freight car at 129th street and Hudson River, whence it was propelled by its own power about 1,000 feet to the station of the 42d street, Manhattanville and St. Nicholas Avenue Railroad, at 129th street, between Twelfth avenue and the Boulevard.

Its air tank was charged, just before the car was taken from the works, with compressed air to a pressure of 2,000 pounds to the square inch, and in the three days that elapsed from that time the loss of pressure was only twenty pounds, which is regarded as small.

The weight of the car complete is 18,000 pounds. Of this, 6,000 pounds may be charged to the car body, 500 pounds to hot water for heating the air, 500 pounds for the compressed air itself, and the rest to the truck and motive equipment and air cylinders. The controller, or throttle and reverse lever as Mr. Hardie prefers to call it, is situated on the front platform, and is strongly suggestive of the ordinary street car controller. A crank handle operates he throttle valve which admits air to the engine cylinders and controls the motions of the car. The reversing lever merely throws the Stephenson link, or regulates the grade of cut-off. A third lever controls the air-brake, and also by swinging over to another position can admit air to the ends of the cylinders for starting, after the cut-off valves have closed, and also make the air pressure momentarily much higher to start off rapidly. This Mr. Hardie calls the accellerator. The brake is released by equalizing the pressure on either side of the piston by a specially designed valve. This action takes place almost instantly. A fourth handle takes the place of the hood switch on the electric car and cuts off the air altogether. The motorman takes all these four handles with him and covers up the top of the controller with a brass cap, thus preventing intermeddling by passengers, and also preventing the soiling of clothing by oil or grease.

The car is 28 feet long, its body being 20 feet long, and the remaining 8 feet being occupied by the two platforms. It has a seating capacity for 28 passengers, and when its compressed air and hot water tanks are charged, it can run 16 miles without recharging, and is capable of attaining a speed of 15 miles an hour.

The motorman controls the machinery with a little lever only 6 inches long, while the rate of speed is graduated by the use of valves, by which the pressure of the motive power on the engine cylinder, usually 150 pounds to the square inch, is regulated.

A movement of the lever one inch to the right lets off the brake and starts the car, while a movement one inch to the left puts on the brake and stops the car, and a further movement to the left starts the car backward. These movements can be made so easily, and the car started, stopped or backed so quickly, that it is contended danger of accident is reduced to a minimum.

The wheels and the hot water and compressed air tanks, which are underneath the car, are concealed by a drop, or curtain, composed of slats of wood.

BY subscribing for "COMPRESSED AIR" you will be repaid by securing the best information that can be obtained on this important power the value of which is constantly growing in importance.

PUMPS VS. COMPRESSORS FOR SHOP USE.

We had thought that everybody was convinced of the fact that air for shop use cannot be economically compressed in air-brake pumps, but if the May meeting of the Central Railroad Club is correctly reported in the Buffalo papers (and these reports are usually official), a committee submitted a report on air-brake testing plants in which they advocated the use of pumps instead of compressors, on the score of economy, and in the discussion that followed, Mr. Higgins, of the Lehigh Valley, and Mr. McKenzie, of the Nickel Plate, were the only dissenting parties.

Unfortunately for the committee, if their opinions are correctly quoted, it can easily be proven that it is economy to replace even a single pump with a compressor, and, in testing plants adjacent to shops where air can be used for other purposes also, thus requiring the capacity of several pumps, their use instead of compressors is extremely wasteful.

Comparisons between the large steam-air compressors and pumps have been made in the past, but we are not aware that any attempt has been made to show the relative economy of pumps and small steam or belt compressors. For that reason it may be well to inquire into the matter. Two years ago the writer made some tests of 8-inch brake pumps in which it was found that for every pound of steam passing through the pumps there was on the average about 2.25 cubic feet of free air compressed to 70 pounds pressure. For every 1,000 cubic feet of air compressed there is therefore required 445 pounds of water, and if the evaporation of the boiler supplying the steam is taken at 8, the coal required is 55.6 pounds. The capacity of one 8-inch pump with 80 pounds of steam is about 1,000 cubic feet per hour, and if we assumed that the pump ran the equivalent of 10 hours per day for 300 days in a year, the annual coal consumption is $55.6 \times 10 \times 300$, or 83 tons. As it is seldom that a single pump is of sufficient capacity for a yard or shop, and as even the smallest belt compressors are usually of the capacity of two such pumps, we will first make a comparison on the basis of 2,000 cubic feet of free air compressed per hour, requiring two pumps consuming 166 tons of coal per year. It might here be remarked that as the speed of pumps vary considerably with slight differences of pressure, it may reasonably be urged that one pump might be made to do this work if higher steam pressure were used; but if this is done the coal consumption is not altered materially, nearly the same amount of steam passing through one pump instead of two.

In considering compressors of small capacity, those driven by belts must not be overlooked. We find by investigation that in this type about 2.8 horse power is required at the belt for each 1,000 cubic feet of air compressed per hour. If the shop engine consumes 3½ pounds of coal per horse power per hour and the loss in transmission by shafting, belts, etc., is 40 per cent., the coal per horse power at the compressor becomes $3.5 \div .6 = 5.8$ pounds, and for compressing 2,000 cubic feet of air it is $2.8 \times 2 \times 5.8 = 32.4$ pounds. For a year of the same number of hours as before, the consumption is $32.4 \times 10 \times 300 = 48\frac{1}{2}$ tons.

In a steam compressor the horse power per 1,000 cubic feet of air compressed, including the internal friction of the engine, we will take as 3.2, though it will vary somewhat with the construction of the compressor. In one having only 2,000 cubic feet capacity per hour, a horse power cannot be expected on less than 4½ pounds of coal with the evaporation we have assumed, and it might easily be more. Taking it at that figure, the annual consumption would be $3.2 \times 2 \times 4.5 \times 10 \times 300 = 43$ tons.

Now a belt compressor of 2,000 cubic feet

capacity per hour and provided with an automatic regulator or governor, can be bought for from $200 to $250, and a steam compressor of that capacity will cost in the neighborhood of $350. Two brake pumps, even if they are not new, will represent an investment of from $100 to $200, according to their age. The comparison between the two types of compressors and the pumps might be summarized in tabular form thus:

	Value of investment.	Coal consumed in tons, per annum.	Cost of fuel, per annum, at $1 per ton.	Saving per annum.	Saving capitalized at 6 per cent.
Two second-hand pumps..	$100	166 tons.	$166 50	.....	.....
One belt compressor.....	225	48½ "	48 50	$117	$1.958
One steam compressor....	350	43 "	43 00	123	2,050

From the columns showing the annual saving and the same capitalized at 6 per cent., it will be seen that if the air-brake pumps were to be had for nothing it would still pay to buy the compressors if they cost less than $2,000. Perhaps a more striking way to view it is that if a road were offered two pumps and a bonus of $1,500 with them, their use to be confined to pumping air for shop use, it would be wise to refuse the offer and to purchase a compressor at market prices. If only one pump were needed it would still pay to buy a compressor of the size mentioned above, and the saving per year in fuel would still be more than $50.

We think the above figures are fair and not in the least exaggerated. If anyone is disposed to quibble over some of the items, let him consider what the comparison would become according to his own figures if coal were at the same time taken at, say, $2.00 per ton, a price which many pay for it.

The figures seem to prove conclusively that though the air-brake pump is admirably adapted for the service which it was designed and is almost beyond criticism when on an engine, it is in the wrong place when compressing air for shop uses. If managers, purchasing agents and others who wield the blue pencils that occasionally disfigure requisitions, could be made to realize these facts, there would be more compressors purchased, for many officials in the mechanical departments who know the wastefulness of pumps cannot induce their managements to purchase compressors.

Before closing, we might make a brief comparison between a compressor, with a capacity of about 18,000 cubic feet of free air per hour (a favorite size with some roads), and pumps of the same capacity. On the same basis as the previous comparisons, but assuming that the compressor can furnish a horse power on four pounds of coal, the annual fuel bill for the compressor would be $346, and of the pumps $1,500. This is not an ideal case, for we know of one company that had ten air pumps in its shops and now has in their place one large duplex compressor. The latter almost pays for itself in one year, with coal at only $1 per ton.—*American Engineer.*

Trolley Car Agnosticism.

Evangelist—My dear man, don't you believe in a guiding power overhead?"

The Reprobate—No, sir! I'm an advocate of compressed air motors. No overhead system for me.—*Brooklyn Life.*

COMMUNICATIONS.

Editor of COMPRESSED AIR:

ROME, N. Y., June 24, 1896.

DEAR SIR—In a previous communication was briefly outlined how I became interested in compressed air.

Before discussing engineering matters, I propose to give some experiences with "capitalists." Speaking generally, there is a class of quasi capitalists and promoters who are cold-blooded, impecunious and unscrupulous, and who are continually on the lookout for a grab. They put on airs of great respectability, wear good clothes, and give an impression that they command unlimited resources and influence. As a rule, they are living on their wits, and they stick like leeches when they get a hold. This will in a measure serve to illustrate how compressed air has had to battle for existence and recognition, and explain how it has been so often "tried and proved a failure."

Is is true that some very bad engineering and false theories have also in a great measure contributed to these failures, as we can see by looking up the patent records. These are the work of amateur engineers or crank inventors, as a rule; but the capitalist or promoter cannot distinguish between them and those which have real merit.

Ordinarily it is difficult to enlist the cooperation of men of financial standing and influence in a new venture, more especially where large capital is required, as is the case with compressed air. It is apparently such a plain, simple and ordinary means of storing and transmitting energy, and so devoid of mystery, that people have not had such a superstitious reverence for it as for electricity. Now, however, a revulsion of feeling is setting in, and we are on the eve of a reaction. Compressed air is gradually taking the place of electricity in many of its uses. Electricians and those having large investments in electrical interests are becoming alive to this fact, as may be noticed from the desperate manner in which they are hammering compressed air in the electrical journals. They also find it necessary, in order to keep the electrical boom alive, to have sensational electrical exhibitions, where the assistance and influence of prominent men is sought, to send messages around the world and keep up the hurrah.

In the summer of 1876, during the time that improvements were being made in the Scott-Moncrieff "air car," in Glasgow, Scotland, a gentleman from New York called and introduced himself as interested in compressed air motors for street railways. He said he was a great believer in its ultimate success, and having read of the Scott-Moncrief motor in the newspapers, was anxious to see it. He was invited to take a ride, and was evidently much pleased with what he saw. He then told me that he was one of a syndicate which was backing an "inventor" in New York to "invent" a compressed air street car, and that they had spent $25,000 without result. This "inventor" was an amateur.

After some irregularities in financial matters, I resigned my position with the above parties and determined to become "inventor" myself; it had a fascination for me, and I made a proposition to an old apprentice mate to join me, provided he would supply funds. An agreement was made, and we filed an application for a patent. We then entered into negotiations with the Edinburgh Street Tramway Co. to build a motor car. They very favorably considered our project, and agreed to furnish us every facility. We had completed our plans, and were getting estimates to have the work done, when an engineer from New York came to me with a letter of introduction from my former visitor. He stated in the letter that the bearer had been sent to examine my plans and report to the New York syndicate, and if the report was favorable I would be sent for. He

remained a week, during which time we disclosed our plans freely, and entertained him highly, taking him around to various places of interest in Scotland.

Before leaving I gave him to understand that as I now had a partner, we would both have to go. He thought this would be satisfactory, and expressed himself as very favorably impressed with our plans. Shortly after his arrival in New York we received the following cablegram :

"Everything satisfactory. Take Saturday's steamer."

Saturday's steamer arrived in New York on the glorious Fourth of July, 1877, with both of us on board.

The day following our arrival we had a conference with the leading members of a new syndicate which had been organized, and found that an agreement had been drawn up and signed by all the parties thereto, including ourselves. Our American engineer friend had acted as our attorney, claiming that we had given him a verbal power of attorney, which was false. It was supposed that as we were "greenhorns," we would acquiesce and ratify it. In this they were mistaken, and a new agreement was drawn up which was more equitable. It transpired afterwards, that our being sent for was a secondary consideration. Our American Engineer had represented, on his return, that he had seen our plans, and that they were just his idea. The syndicate was therefore organized without us, and our American friend appointed engineer, all having equal shares.

It fortunately happened that he had no experience designing machinery, and knew nothing of the subject he had undertaken. He therefore on the following day represented that he would have to hire help, and advised that as we were familiar with the subject, they had better send for us as his assistants. This was agreed to, and one of the "capitalists" of the syndicate was induced to withdraw, so that we might have his share between us. This was one of the terms of agreement submitted to us on arrival. The new agreement put us on an equal footing, and we set about getting out our first motor.

It very soon became apparent to us that our American associate was more ornamental than useful, and this was fully as apparent to himself. He tried, however, to make up for it in a social way. He also impressed upon us the importance of our being loyal to each other. This, of course, was so that we would not "give away" on him. He further represented to us that we had better get out of town to build our first motor, as the others would be dropping in on us all the time, criticizing and finding fault, and we would have no peace. To the other members he represented that it would be judicious to get out of town and locate in some quiet place, where patent pirates would not spy on us and steal our "inventions." They highly commended his good judgment and forethought, the result being that we located at Newburg on the Hudson, quite a safe distance from all kinds of molestation.

I can see now that his real motive was to conceal from the others, as long as possible, his utter incompetence. While in Newburg he contrived to handle all the money in paying shop and hotel bills, and, as we found later, had charged $2 per day for each of us for "extras," which we never got.

It was only a few months before he was found out, and upon the organization of our company, after a successful test of our first motor, he was dropped, while I was appointed chief engineer, and my friend assistant engineer.

In my next I propose to give some of the inner workings of the "company."

Yours truly,

ROBERT HARDIE.

Editor of "COMPRESSED AIR":—

On reading an article in the last number of your useful little journal, entitled "Pumping by Compressed Air," I was

somewhat surprised to see that you attributed the working of the Pohlè Air Lift Pump and its kind to the air acting as a piston, forcing the water in sections to a higher elevation, on the same principle as that of a common chain and button pump.

I believe this is the wrong conception of pumping water under the conditions in question.

I have had occasion to experiment very largely in this direction, and before active work I adopted a different theory that was fully proven by later practice.

This was that the air, mingling with the water after its discharge from the air pipe, lightened the water to the extent of its impregnation, and so creating a mixture whose equilibrium can only be established with the solid columns of water surrounding it by its raising higher.

This height will be proportionate to the amount of air in volume contained in the water.

This theory can be nicely illustrated by bending a glass tube in the shape of a letter "U" and placing soap-suds in one leg and water in the other; it will be seen that the lighter suds will rise to a height compared to the solid water in proportion as they weigh in bulk.

Upon this theory I have obtained the best results in lifting water.

I first reasoned that if this was the correct theory, the slower the air traveled upward the longer I would have it to do the displacement act, and I accordingly constructed a jet on the end of the air pipe similar to the opening in a common steam-whistle, so that I would divide the air into as small particles as possible, knowing well that it required a longer time for a small bubble to travel upward than it did for a larger one.

The results attained fully justified my theory.

Comparison with an air nozzle of the Pohlè type, with the same amount of opening, gave a difference of 10 per cent. in favor of my construction.

I will also say that there was no eduction pipe used; the air pipe was simply lowered down in the 8-inch well to a depth of 160 feet, and the water was lifted about 30 feet.

EUGENE BIDDISEN.

The Portland Gold Mining Co.,
Victor, Colo., July 30, '96.

IMPRESSIONS MADE BY THE COMPRESSED AIR STREET CAR.

During the early part of this month a test was made of the Hardie Compressed Air Street Car Motor on the street railway in New York that runs through 125th street to Fort Lee Ferry, and the tests prove the system feasible and economical.

We have been accustomed to the easy-going horse car that carried us along at a little faster gait than we could go ourselves, and which saved our legs but killed the horses. But we became attached to the horse car and its peaceful jog, even if it didn't take us along as fast as we wished. As distances became greater it was necessary to adopt other means of transit. Electricity was plunged on the public with force as irresistible as itself. Experiments were made, and as they proved that locomotion could be accomplished by it, it was put in practice by promoters whose zeal and money were lavishly spent to establish it. Thus the trolley came into use and it proved its capacity and carries us along with startling effects. People tolerated the overhead wire, with its deadly inhabitant. Many innocent lives have met shocking ends because of the trolley, until it has become the curse of cities and the enemy of the family. No wonder that it has called down imprecations, and that a dangerous hostility to it has developed. In one city alone over 200 lives have been crushed out. There is no doubt that the personal hostility of those who suffered these losses and were affected by these

deaths would alone prove dangerous to its interests.

To minimize the dangers to which human life is put is the constant occupation of many deserving men; and he who extirpates the trolley and gives us something that lessens the danger, is worthy of a crown.

The cable car, too, has its limitations and its dangers, and can be classed in the same category with the trolley, only that it may be stopped more easily and runs more slowly.

The line on which the compressed air car is now being tried is a cable line, and there are a great number of cars always running. The compressed air car is sandwiched in between the cable cars, and takes passengers the same as the rest.

On Monday, August 3d, the writer boarded this compressed air car almost at the end of the second trip. Each trip is 2½ miles, and two trips are made by one charging of air power. The car is about the same in appearance as any other first class street car. The compressed air is stored in tanks under the seats. An ordinary arrangement for controlling the movements of the car is on each platform. As the car neared the end of the route, it was sidetracked on a little spur of track that had no cable groove. Two cable cars followed our car on the regular track, and got ready to go back. A great commotion took place as each car started. The gripman stood with lever in hands, eyes starting and nostrils dilating. Men were running back and forth, signaling and shouting. When all seemed to be ready, the shout came, "Let 'er go!" and with a jump and stretching and unrestrained energy, it pounded its way until it reached a point where the grip could be released, when the speed was relaxed and the car became manageable again. This performance is witnessed every day at terminal points and at curves, and the dangers are so evident that a prominent place on Broadway, New York, is known as "Dead Man's Crossing." While this Comanche-like ceremony was being enacted our car stood awaiting its turn. When it came, the motorman turned the lever one inch and the car moved forward with the ease of a ferryboat as it leaves its slip. It proceeded with a quiet that was only punctuated by the fierce bell made necessary by the trolley and cable. I stood on the front platform and observed the faces of people who waited to get on. They stood and looked upon the noble carriage as if it were a chariot of peace.

As we passed over the iron-paved roadbed that indicated the presence of underground fixings, with riveted "frogs" and manholes, the little gate at my side rattled in its socket, and I called the attention of the assistant to it, for it was annoying. He said it could easily be repaired. It struck me then that such a little thing would not be noticed on the trolley or cable cars, with their fierce grindings of gears and grips. The sputtering of fire and the sliding grip drown everything save the mightiest sound or piercing cry of a victim. The ride was otherwise uneventful. The fact stands that this car runs and is controlable and safe. The fact that it made this trip with first class results is evidence that it can continue to do so. In view of experience herein stated, there is no obstacle too great, no amount of money that should not be spent to further this enterprise to a successful end. The result at stake is full of interest to all. It involves adjuncts to progress that must be promoted, rapid transit, peaceful conditions and safe application.

As I stepped from the car at Third avenue and 125th street, a man stood on the curb looking wistfully at this car as it moved along. He turned away and said: "I am glad to see it come; it's too late for me, though; that cable killed my little girl."

STONE-CUTTING BY AIR TOOLS.

Perhaps the most marked improvement in the stonecutter's art since the stone age has been the introduction of the use of compressed air. For centuries the hard, unyielding stone had been fashioned into shape by the ceaseless efforts of the hammer and chisel; and while other trades adopted newer and cheaper methods of manufacture in rapid succession, no means could be devised to hasten the tedious processes of stonecutting.

The arm of the carver could only deliver a comparatively small number of blows per minute, but by the use of pneumatic carving tools this number was multiplied to such an extent that the blows following each other in rapid succession are in effect one continuous blow.

As the cutting power is always ready, the carver had merely to guide the machine and chisel. He can thus give his whole attention to his work, and the result is shown in the increased amount of work accomplished, and the work is done much better.

These tools were crude at first, being complicated and liable to injury, and the continual breakdowns were a constant source of annoyance. They have been greatly improved and simplified until the latest and best types are but very simple in their make up, i.e., the cylinder or case, and plug for same, and the hammer or piston that delivers approximately 20,000 blows per minute on the chisel. The first tools introduced were operated at 15 to 20 pounds air pressure, as a higher pressure caused them to vibrate or "kick" to such an extent that the operator could not hold them. Now, however, 80 pounds pressure is easily handled, as the disagreeable "kick" has been overcome by the introduction of an air cushion which stops the hammer from striking the cylinder head on the up stroke. The machines do not run continuously as formerly, and now only use air while actually employed in cutting, and automatically stop the instant the chisel is removed from the stone. Soon after hand tools became widely used, a need was felt for a machine to surface granite, and a large and powerful pneumatic tool mounted on a radial arm, which is in turn supported on a vertical column or post, met the needs of the cutter. These powerful machines eat away granite at an astonishing rate, and have no difficulty in surfacing 60 or more square feet per day.

With the introduction of compressed air into the stone-cutting establishment, other uses were soon found for such a tractable servant, and now compressed air operates the overhead traveling cranes and hoists, pumps, sand and water for gang saws, blows the blacksmith's fires, and operates the quarryman's rock drills, gadders, channelers, etc.

No doubt in the future still other uses will be found for compressed air, and any one putting in an air plant would be wise in making ample provision for future needs.

The Uses and Advantages of a Public Supply of Compressed Air.*

BY FRANK RICHARDS.

It occurs to me that it will be of interest to many readers of the "American Machinist," and that I will be doing an actual, practical service to many of them, if I try to put in easily readable shape some statement of what could be done—say in any of the large cities—if a supply of compressed air should be established and maintained, and the air distributed to all customers who should want it, as water and gas are now so universally provided.

There are no difficulties or uncertainties whatever in the way of establishing a general compressed air supply. Air compress-

* "American Machinist."

ors of considerable capacity are now made, and nearly as well understood as the steam engine, and their performance can be computed and guaranteed with great accuracy and reliability. The conveyance and distribution of the compressed air involve no difficult problems, no experimenting, no risks, no enormous expenses. Comparatively small pipes will convey a great amount of power, and they can be cheaply laid, and made and kept tight, by the resources of everyday mechanical skill. No expansion strains of any importance occur, as with steam pipes. The air, as delivered to customers, can be metered as accurately as gas; so that everything can be conducted upon a thorough business basis.

It may be better at the latter end, rather than at the beginning, to go into a detailed consideration of the cost of the compressing plant, and of its maintenance and operation, with the details of its construction and arrangement. It will be better first to see whether the service would be worth anything to us—and if so, how much—before proceeding to consider the cost of it.

It is necessary at the outset to determine what pressure of air shall be maintained in the system, as the scope and mode of its employment must, to a certain extent, be limited or controlled by that. We may assume, then, a pressure of 100 pounds, gauge, which, upon the whole, and at this stage of the game, may be better adapted to an all-around service than any other pressure, although much might be said in favor of a pressure much higher.

Although, as I said above, we will not now consider in detail the cost of compressing and delivering the air, still, in order to have some practical idea of the cost—and, therefore, the saving or the loss in the use of the air, under the various conditions which we may mention—it will be desirable to have some approximate figures for a standard by which we may measure the economy of the air service as compared with other means applicable to each individual case.

It is generally found to be most convenient in making computations or comparisons, or in keeping records or accounts pertaining to compressed air practice, to conduct all such transactions upon a free-air basis. Free air is the volume that we have at the beginning and at the termination of compressed air operations; but during the use of the air, the volume will be less and will vary at different stages. Supposing the air to be compressed at or near the sea level, and at normal barometric pressure, the volume actually delivered at 100 pounds gauge pressure, and at normal temperature, will be only .1304 of the volume of free air; or, 1,000 cubic feet of free air will, as actually delivered to the customer, be only 130.4 cubic feet.

Let us assume, then, for the sake of keeping the cost feature before us in our compressed air practice, that the air is delivered to the consumer at an established and uniform rate of five cents per thousand cubic feet of free air—the pressure maintained being, as before assumed, 100 pounds by the gauge. This estimate of cost is, for the present, to be taken entirely upon trust; although I could easily show that the rate would be a perfectly safe and profitable one for a company who should undertake the compressing and furnishing of the air and develop sufficient business in it. With coal at $5 per ton (and not talking any nonsense about utilizing idle water powers, where the water is running to waste, and where consequently it would cost nothing), the total fuel cost for compressing the air under the above conditions would be decidedly less than two cents per thousand feet of free air.

The establishment of a public supply of compressed air could not fail to open for it a wide field of usefulness. It is an undeniable fact that it can boast a range and variety of applicability, a Briarean dexterity, possessed by no other transmissible medium. To some extent, in the single

function of power transmission, it would find itself in competition—or, rather, in comparison—with the hydraulic system, with steam, and with electricity. Water transmitted under pressure of 1,200 pounds or more, is in use in various cities of Great Britain; and though the range of its usefulness is restricted to power transmission alone, and that only under narrow conditions of application, it is still an established success, and moderately remunerative to its promotors. Steam, though excellent in the development of power when it gets at its work, and though also available as a conveyor of heat, is not a good traveler, and its inability in this particular is fatal to its extensive employment. Electricity, upon the other hand, is the most sprightly and ubiquitous of travelers, and a ready distributor of both light and power—the latter almost exclusively by means of whirling motors and trains of reducing mechanism, while air may communicate its power in various ways—by the motor or engine at high speeds, or by slow, dead pressure when so required; and in addition to its universal adaptability for power transmission, it has numerous other modes of making itself useful which are possessed by it alone; and it has, above all, the unique advantage of costing nothing, except as it is used, and that it charges only for its actual services when employed.

Pneumatic Dispatch Tubes.

It is announced that Philadelphia is to be the first city in the United States to be generally equipped and gridironed with a system of pneumatic dispatch tubes, for mail matter, telegrams and light packages. The pioneer American pneumatic tube for postal service was put in operation in Philadelphia a few years ago, and is a great practical success. It is about a half mile in length, extending from the Philadelphia Stock Exchange to the Post Office. The tube is 6½ inches in diameter and is capable of carrying 48,000 letters per hour.

There are some private or semi-private installations of pneumatic dispatch tubes in use in this country by the telegraph offices and the newspapers, but generally we are far behind European cities in our appreciation and use of this means of transmission. The system has been in efficient operation for years in London, Paris, Berlin and Vienna. The systems employed in these different cities are quite different from each other in the details of construction and operation. For instance, London uses what is known as the radial system, and Paris uses the circuit system. In London, both outgoing and returning tubes are laid radiating from a central station; while in Paris a single pipe from the central station makes a circuit of outlying stations and returns to the starting point. The circuit system is used in Vienna, but in Berlin the circuit has been changed to the radiating system.

The tubes employed in all the European installations are of comparatively small diameter. London operates 42 stations and 34 miles of tubes, carrying, it is estimated, 57,000 messages per day. Paris, with less than 20 stations, transmits nearly as many messages as London. Berlin has 38 stations and 28 miles of double tubing.

In the details, both of construction and operation, there is quite a diversity of practice. In London the individual carriers are operated upon by the propelling force; in Paris, pistons take long trains of carriers after them. In some cases a vacuum in front of the carriers is created, and in others compressed air operates behind them, or sometimes a combination of both methods is employed.

The sticking of carriers in the tubes is a serious occurrence, but means have been devised for meeting such a contingency. The fine system of sewers in Paris leaves all the tubes in that city easily accessible.

When a pipe is obstructed a diaphragm is attached to the end of it, and a pistol shot is fired into the tube through an opening just below where the diaphragm is placed. The sound acting on the diaphragm, closes an electric circuit and makes a mark on a chronograph. The sound wave traveling through the tube, meets the obstruction and is reflected, and upon its return makes another mark on the chronograph. The interval of time indicated by the chronograph gives a ready means of determining the distance of the obstruction from the end.

We should be able now in this country to make a fine exhibit and a great success of pneumatic transmission, as we have the benefit of forty years of European experience.—*American Machinist*,

COMPRESSED AIR.

(CONTINUED.)

We would here have a case of reheating by natural conditions, and the possibility of obtaining more power at the motor than was expended at the compressor is made apparent.

All this appears to be but theory, yet the value of the argument lies in the fact that it points to what may be accomplished in the future and to the importance at present of low initial temperature at the compressor and high temperature at the motor. It is a common thing to see air compressors at work in engine rooms drawing the air into the cylinder at the temperature of the engine room, which, in many instances, especially in winter, is 50 degrees higher in temperature than that of the air on the outside. Even where air compressors are used with concentrated inlets made for the express purpose of being connected with the atmosphere from the outside, this question of economy by low initial temperature is frequently neglected. For every 5 degrees by which the initial temperature of the intake air is lowered, there is a gain of one per cent. in volume.

It is not a difficult matter to construct an air compressor plant where the intake air is made to pass over refrigeration pipes. In cities where ice-making plants are in operation, the best point to place the air compressor is alongside the ice-making machines, the combination of the two industries being advisable.

On the other end of the line reheating is of great importance. A perfect reheater has not yet been found, though at this time reheaters are in use which give practical results. It has already been demonstrated that compressed air may be increased in temperature and thus proportionately increased in volume and efficiency by the application of heat in a very economical manner, the quantity of coal consumed in proportion to the gain in economy being very small.

Mr. Robert Hardie, in his experiments with a pneumatic motor using a hot water reheater, has figured the cost of reheating at one-eighth the coal required at the compressor. Professor Haupt, referring to this heater, makes the following statement:

"The power required to compress 1,000 cubic feet of free air to 2,000 pounds per minute would be 400 horse-power, consuming 1,200 pounds of coal per hour at a cost of $1.80 (at $3 per ton), and the cost of reheating would not exceed 22 cents to double the work performed. That these statements are not simply theoretical deductions have been proved by actual tests. The Rome air motor when using a reheater ran fourteen miles on a consumption of 308 cubic feet of free air per mile. When the air was not reheated, the consumption of air per mile was 661 cubic feet."

The first loss in air compression, that due to the fact that the heat produced cannot be maintained, is an unavoidable loss.

The second loss may be called the influence of the heat of compression, and is due to the fact that this heat increases the relative volume of the air and resists compression. This heat of compression has long been the *bete noire* of air compressor builders. At first it seriously affected the valves and packing, and this served as an argument in favor of injecting water into the cylinder, the claim of manufacturers being that by keeping down the heat of compression repairs would be less and accidents due to the destruction of parts by heat would be avoided.

The injection of water into the air cylinder is usually known as the Colladon idea. Compressors built on this system have shown the highest isothermal results. It is plain that the injection of cold water in the shape of a finely divided spray directly into the air during compression will lower the temperature to a greater degree than to simply surround the cylinder and parts by water jackets.

Two systems are in use by which it is attempted to absorb the heat during compression. These systems divide air compressors into two classes—

(1) Wet compressors.

(2) Dry compressors.

A wet compressor is one which introduces water directly into the cylinder during compression.

A dry compressor is one which admits no water to the air during compression.

Wet compressors may be subdivided into two classes—

(1) Those which inject water in the form of a spray into the cylinder during compression.

(2) Those which use a water piston for forcing the air into confinement.

The advantages of water injection during compression are as follows:

(1) Low temperature of air during compression, hence a reduced mean resistance and a saving of power.

(2) Increased volume of air per stroke, due to filling of clearance spaces with water, and to a cold air cylinder.

(3) Low temperature of air immediately after compression, thus condensing moisture at the air receiver.

(4) Low temperature of cylinder and valves, thus maintaining packing, etc.

(5) Economical results due to compression of moist air. See Table No. 4).

The first advantage is by far the most important one, and is really the only excuse for water injection in air compression.

The percentage of work of compression (dry air) which is converted into heat and lost when no cooling system is used is as follows :

Compressing to	2	atmosph's,	loss	9.2 p.c.
"	" 3	"	"	15.0 "
"	" 4	"	"	19.6 "
"	" 5	"	"	21.3 "
"	" 6	"	"	24.0 "
"	" 7	"	"	26.0 "
"	" 8	"	"	27.4 "

We see that in compressing air to five atmospheres, which is the usual practice, the heat loss is 21.3 per cent., so that if we keep down the temperature of the air during compression to the isothermal line, we save this loss. The best practice in America has brought this heat loss down to 3.6 per cent. (old Ingersoll Injection Air Compressors , while in Europe the heat loss has been reduced to 1.6 per cent. Steam-driven air compressors are usually run at a piston speed of about 350 feet per minute, or from 60 to 80 revolutions per minute of compressors of average sizes, say 18 inches diameter of cylinder. Sixty revolutions per minute is equal to 120 strokes, or two strokes per second. An air cylinder 18 inches in diameter filled with free air once every half second, and at each stroke com-

pressing the air to 60 pounds, and thereby producing 309 degrees of heat, is thus by means of water injection cooled to an extent hardly possible with mere surface contact. The specific heat of water being about four times that of air, it readily takes up the heat of compression.

A properly designed spray system must not be confused with the numerous devices applied to air cylinders by means of which water is introduced. In some cases the water is merely drawn in through the inlet valves. In others it passes through the centre of the piston and rod, coming in contact with the interior walls of the air cylinder between the packing rings. Introducing water into the air cylinder *in any other way, except in the form of a spray, has but little effect in cooling the air during compression*. On the contrary, it is a most fallacious system, because it introduces all the disadvantages of water injection without its isothermal influence. Water, by mere surface contact with air, takes up but little heat, while the air having a chance to increase its temperature, absorbs water through the affinity of air for moisture, and thus carries over a volume of saturated hot air into the receiver and pipes, which on cooling (as it always does in transit to the mine), deposits its moisture and gives trouble through water and freezing. It is therefore of much importance to bear in mind that unless water can be introduced *during compression to such an extent as to keep down the temperature of the air in the cylinder*, it had better not be introduced at all.

If too little water is introduced into an air cylinder during compression, the result is warm, moist air, and if too much water is used it results in a surplus of power required to move a body of water which renders no useful service.

The following table deduced from Zahner's formula gives the quantity of water which should be injected per cubic foot of air compressed in order to keep the temperature down to 104° F. :

Compression by atmosphere above a vacuum.	Weight of water to be injected at 68° Fah. to keep the temperature at 104° Fah. in lbs. of water and per lbs. of free air.	Weight of water to be injected at 68° Fah. to keep the temperature at 104° Fah. In lbs. of water for 1 cu. ft. of free air
2	0·734	0·056
3	1·664	0·089
4	1·469	0·113
5	1·701	0·131
6	1·891	0·145
7	2·063	0·158
8	2·204	0·167
9	2·329	0·179
10	2·440	0·188
11	2·542	0·195
12	2·634	0·202
13	2·719	0·209
14	2·798	0·215
15	2·871	0·223

W. L. SAUNDERS.

MR. S. E. JARVIS, of Lansing, Mich., the inventor of the Jarvis Compressed Air Motor, writes as follows :

"I have discovered much of value in working with my air motor, but have never thought much about making it public, as few seem to be working on the same lines (that is, with low pressures for motor cars) as I undertook to perfect. It is a most interesting line of invention to prosecute and develop.

"In my efforts everything undertaken was upon a full-sized scale, with one mile of real street car track and one full size 24-foot car and a small but complete compressing plant with compressor of my own design that produced diagram unsurpassed for efficiency in a single compressor. I had many different things to contend with in getting a coupler that would automatically, when mounted upon a car and when the car was in motion, connect with the valve in the main located in the street in an effective and practical manner, and that would make an air-tight joint even with mud and snow upon the valves; but I finally succeeded in getting a device that would make the contact under any condi-

tions of track or weather, in night or day, or under two feet of water if required; and I could connect with mains, make the joint open, the valves take in air and close the valves and break the joint in just 3-10ths of a single second, as I can prove by a diagram taken while doing so.

"It is quite interesting to look back now, after having gone through with all of the details and the running of the car several thousands of miles—sometimes as much as 50 miles a day—to see how well and accurately the devices worked and the care with which the car could be handled and run, and it is to be regretted that I had to discontinue the scheme just as all of the details had been reduced down to bed rock. But the panic of '93 and the lack of proper financial support put this most promising enterprise in the background so far that I can at present find no hope for its revival.

COMPRESSED AIR.

We have something to say ourselves this month in relation to our little magazine and its mission. First of all we are endeavoring to get all the existing literature there is of value on the subject of air power, under the covers of this publication. It is to make known to the general public the usefulness of this power in the varied activities of manufacturing and domestic pursuits.

Each month we publish some new application wherein compressed air is made to accomplish some work hitherto done by hand or other method, both laborious and expensive.

As these new applications become known they are adopted, hence the necessity of publishing this information accurately is important. The wide field open for compressed air appliances means that commercial interest in the subject must soon be manifested.

COMPRESSED AIR is the first and only publication devoted to the interests of compressed air. Its life depends on the patronage of people who are interested in this subject.

The little magazine has thus far met with continued approval and support. It has stimulated inquiry into this useful power that has so long been neglected and misunderstood. The notices so frequently given to it by the secular press have been because of the appearance of the little magazine upon the exchange editors desk.

Subscribers are being enrolled from all parts of the world. Asia, Africa and many countries in Europe being represented. Our aim is to enroll on our list every shop, where the development of mechanical devices is a matter of importance. Engineers and mechanics who would advance themselves may profit by reading this magazine.

Advertisers have already felt its influence upon trade, and those who would secure some of it will be benefited by being represented in its columns.

Therefore we look for support in the fraternity that goes to make up the mechanical world. Having secured this our scope of usefulness will be enlarged and the good work of giving valuable information for the cash consideration of one dollar a year for subscription, will go on merrily and the labors of those who have taken up the work will be lightened as they see their labor being appreciated.

WHAT THEY THINK OF "COMPRESSED AIR."

From Scientific Mechanic, June 15, 1896.

We have received several copies of a new journal, entitled "COMPRESSED AIR," published at No. 26 Cortlandt street, New York. It is a little monthly paper devoted to compressed air and allied branches of engineering. There is no doubt that a want of such a publication exists, though probably not so long-felt as in the average case of newborn publications. But certain we are that it will be longlived, for this science is going to be one of great importance in the future.

From American Engineer, July, 1896.

"COMPRESSED AIR," a monthly publication published at 26 Cortlandt street, N. Y., is an interesting periodical,and although only five months old, it has developed wonderfully in that brief period. The rapidly extending use of compressed air for power purposes in all kinds of shops, in contractors' work, and in other lines too numerous to mention, gives this paper a large and growing field. From its pages it is evident that its editors and publisher are directing the attention of its readers to the thoroughly practical uses of compressed air and the most economical methods of employing that useful agent. That is just what is needed, and we can heartily commend the pnblication to those who are or ought to be interested in the compression, transmission or use of air.

From Machinery, July, 1896.

"COMPRESSED AIR," 26 Cortlandt steeet, New York.—This little paper is devoted to the useful application of compressed air. There is certainly a field for this publication, as the widening uses of compressed air seem to warrant a paper devoted exclusively to it.

From Farm Implements, June, 1896.

"COMPRESSED AIR."—The first numbers of a new publication, "devoted to the useful application of compressed air," and bearing the above title, have reached us. The many uses to which compressed air may be put are not apparent until the subject is studied, and this paper treats the matter practically. With an unexplored field of such extensive area there should be a place for the publishers to do good work. It is published monthly by W. L. Saunders, at No. 26 Cortlandt street, New York.

Railway Master Mechanic, August, 1896.

A bright little monthly, called "COMPRESSED AIR," was recently started in New York and has been steadily growing in interest and value since its first issue. It is devoted to the ample application of compressed air, and presents each month brief accounts of the latest developments along this line. This paper is published at 26 Cortlandt street, New York; the price is $1.00 per year.

WE are anxious to publish new and interesting matter pertaining to the useful application of compressed air. The columns of this little magazine are always open to discussions of the subject and in any of its phases.

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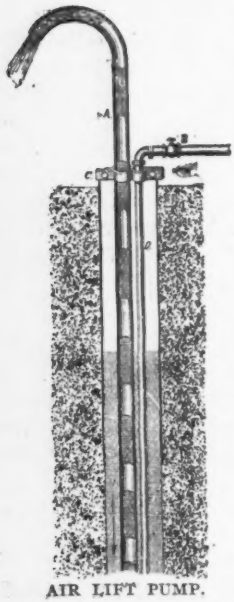

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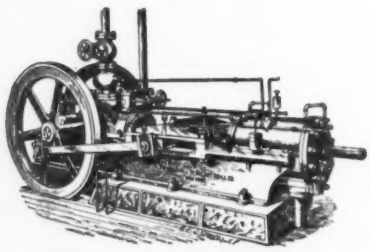

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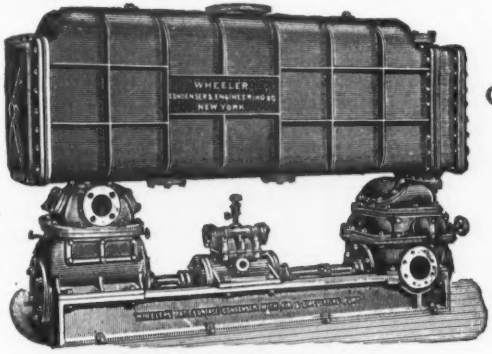

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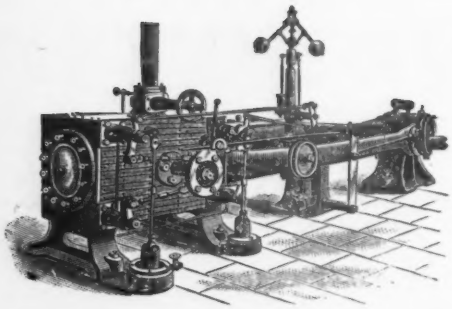

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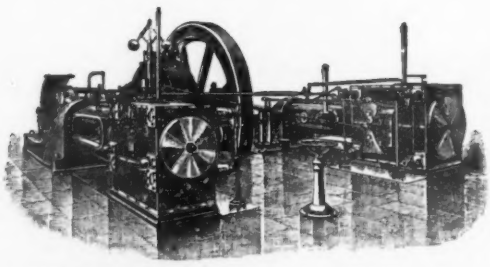

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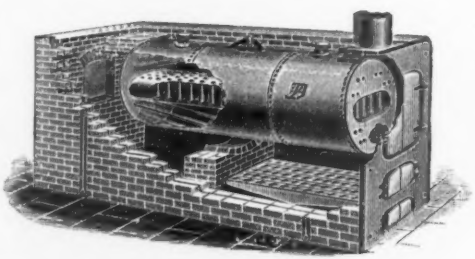

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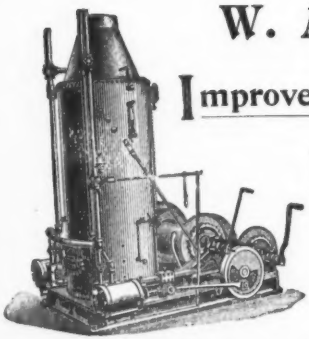

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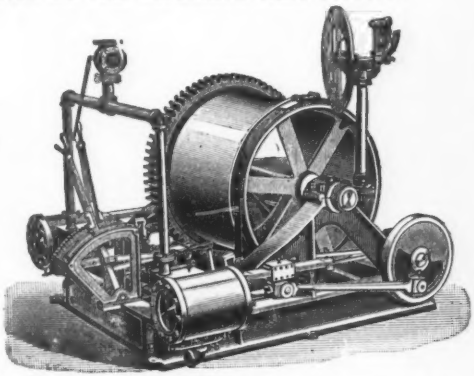

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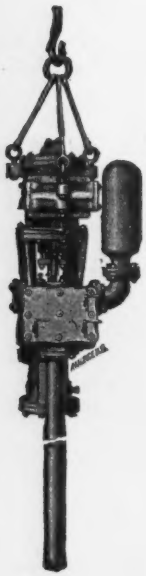

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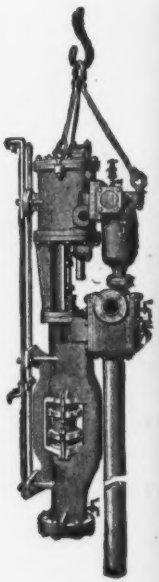

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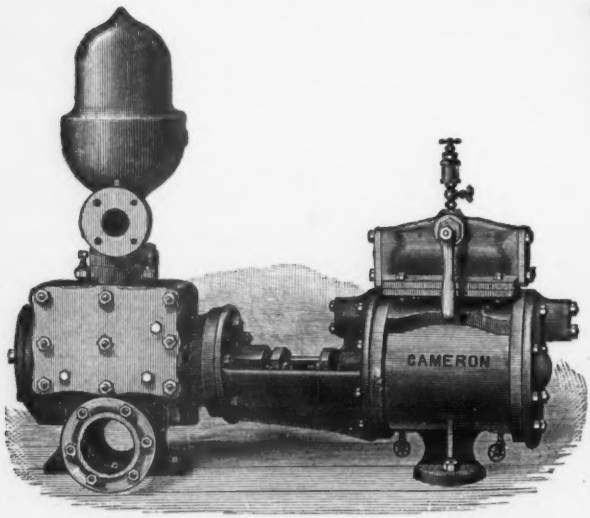

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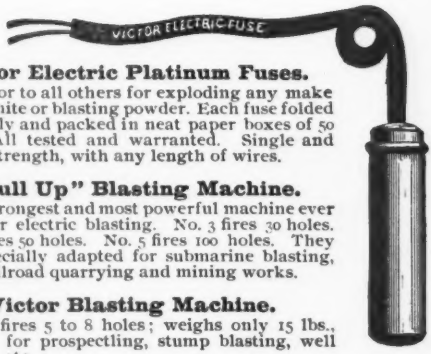

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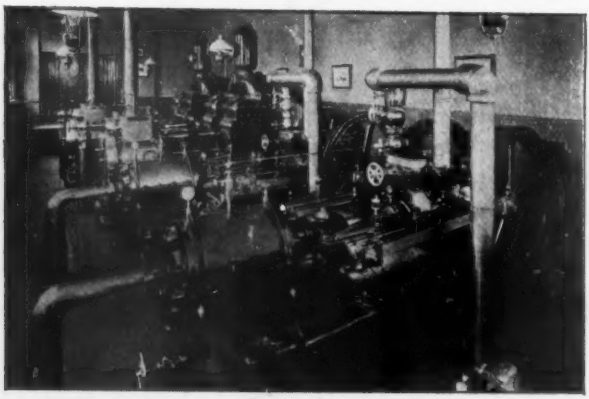

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